Université de Lille

POLYTECH LILLE

Laboratoire Génie Civil et géoEnvironnement Lille Nord de France

SUNRISE SMARTCITY

Master Urban Engineering and Habitat

(2022 – 2023)

Course Smart City

Ch4: Smart Sewage System

Professor Isam SHAHROUR

Objective of the sewage system

Management of :

- Wastewater
- Rainwater (storm water)

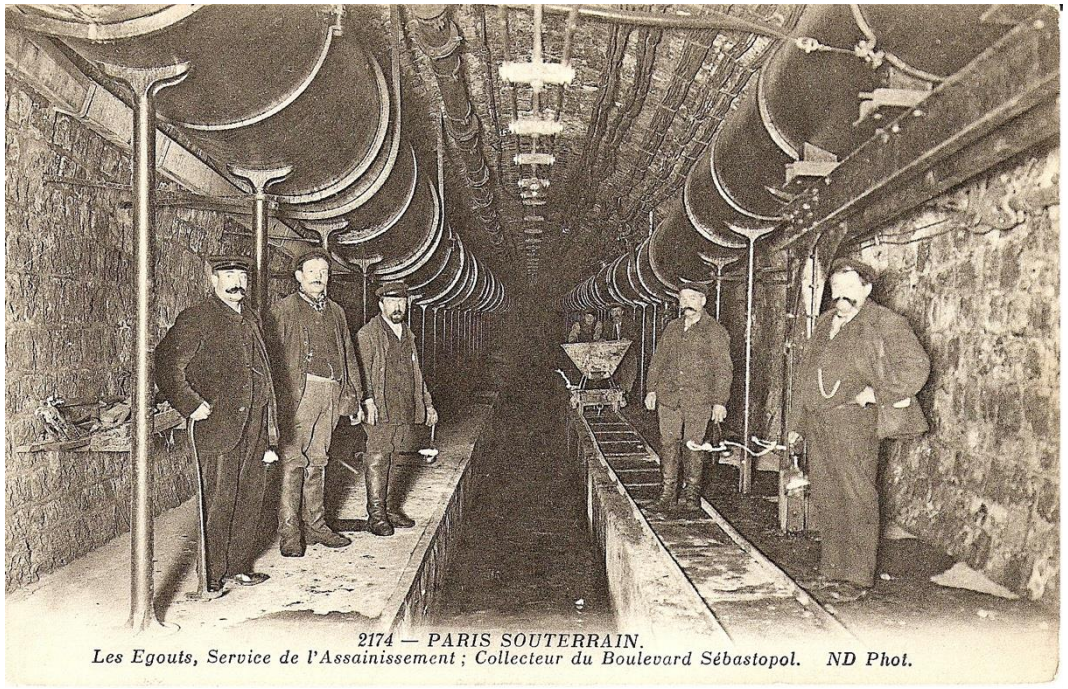
Functions of the sewage system

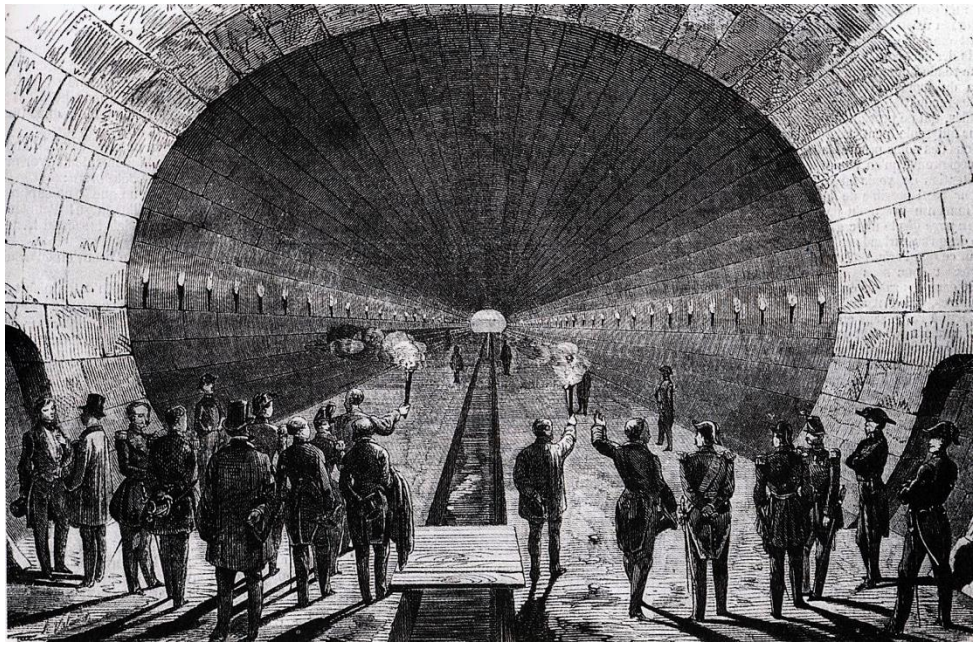
Management of :

- The wastewater (sanitation system)
- The rainwater (storm water system)

Paris in the 19th Century

1860: Governor of Paris Haussmann (Napoleon III) started the construction of large water tunnels





Paris (1858).

Outline

- Presentation of the sewage system (how does it works ?)
- Smart sewage system concept
- Smart pilot project (SunRise)

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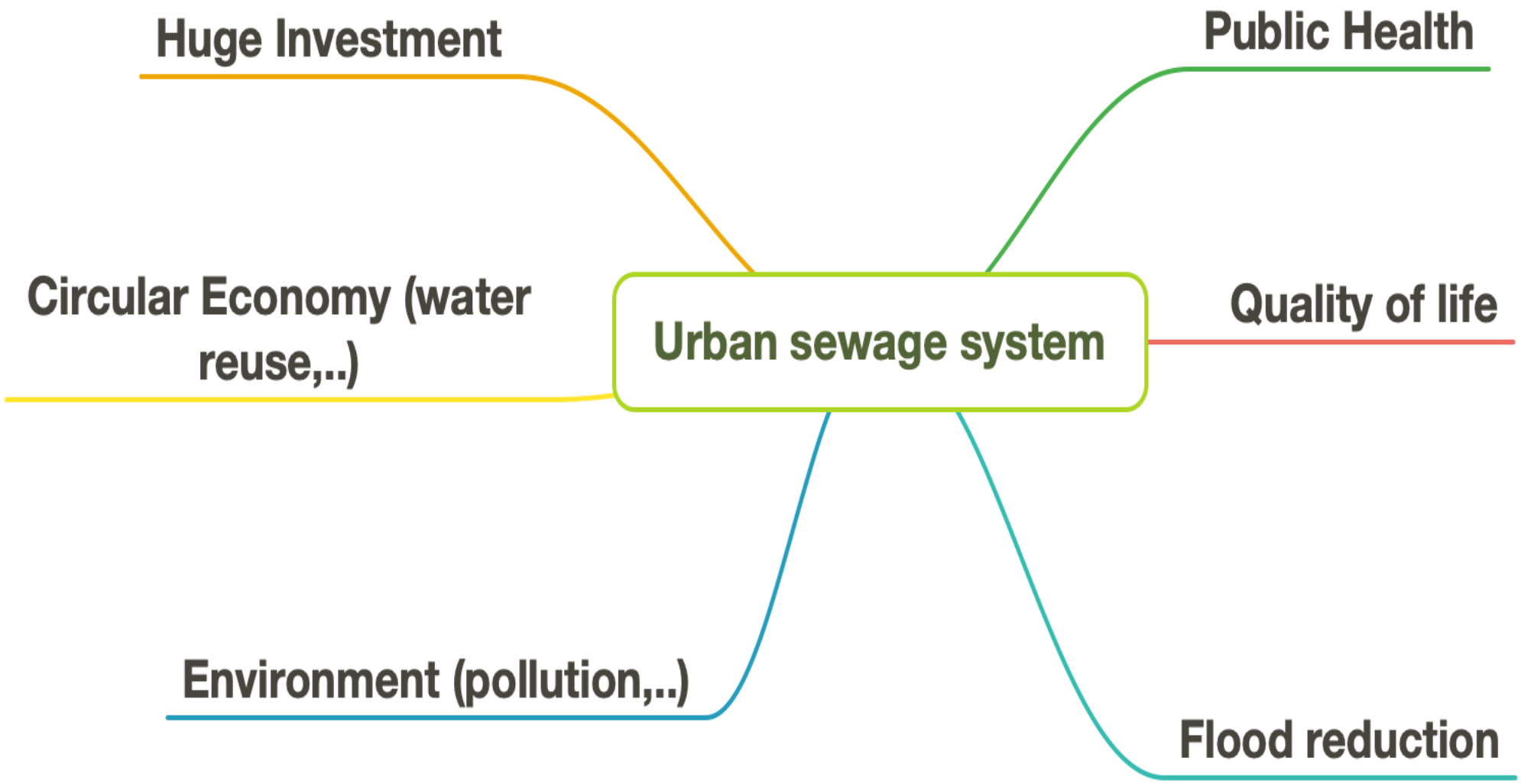
sewage systems: major urban concern



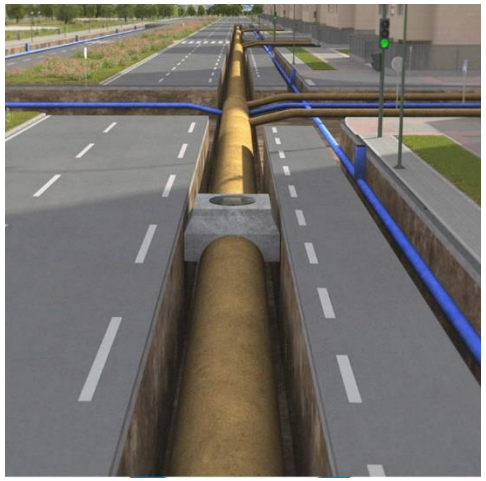
I) Storm water management (rainwater):

- Rainwater collection
- Rainwater transportation to natural environment (rivers, lakes, groundwater, sea,…)
- Flood risk reduction

Stormwater System

Inlets

Underground Network



Outlets

Retention/detention basins

How Do Sewer Systems Work

II Wastewater management:

- Water Collection
- Transportation to a treatment plant
- Water treatment
- Transportation to natural reservoir or to re-use purposes
- Reduce/avoid soil and water contamination

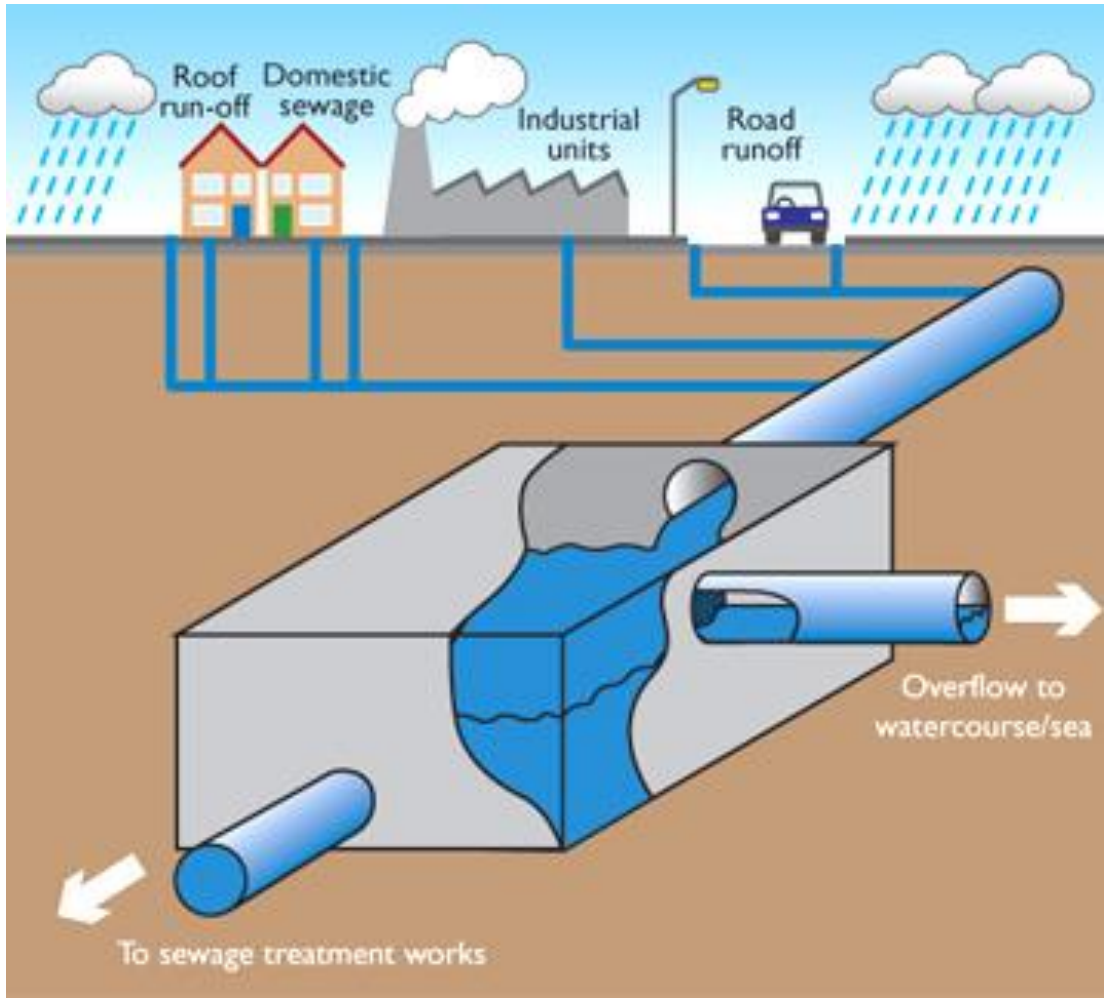
Wastewater System

Domestic use

Underground Network

Wastewater treatment plant

III - Combined sewage system




Fosse toutes eaux 3000 Litres
Sortie des eaux usées vers poste de relevage
Ventilation de fosse et du poste de relevage
Poste de relevage

Sewage system performances

Flow rate:

- Minimum: to avoid deposit
- Maximum: to avoid overflow
- Hydraulic operating (hydraulic pumps)

Sewage system performances

Water quality:

- Control water discharge

- Management of the water treatment plant

Challenges of the sewage system

Stormwater

- Reduce flood risk
- Reduce risk of contamination
- Preservation of rainwater by infiltration and transport for natural water resources
- Re-use of rainwater (domestic, industrial..)

Wastewater

- Reduce contamination risk (Health, environment)
- Re-use of wastewater (domestic, industrial..)

- Optimal management (collection, transport, treatment,..)
- Reduction of energy consumption
- Evaluation of the performances
- Optimization of the investment

London: Where Does Your Sewage Go I Didn't Know That

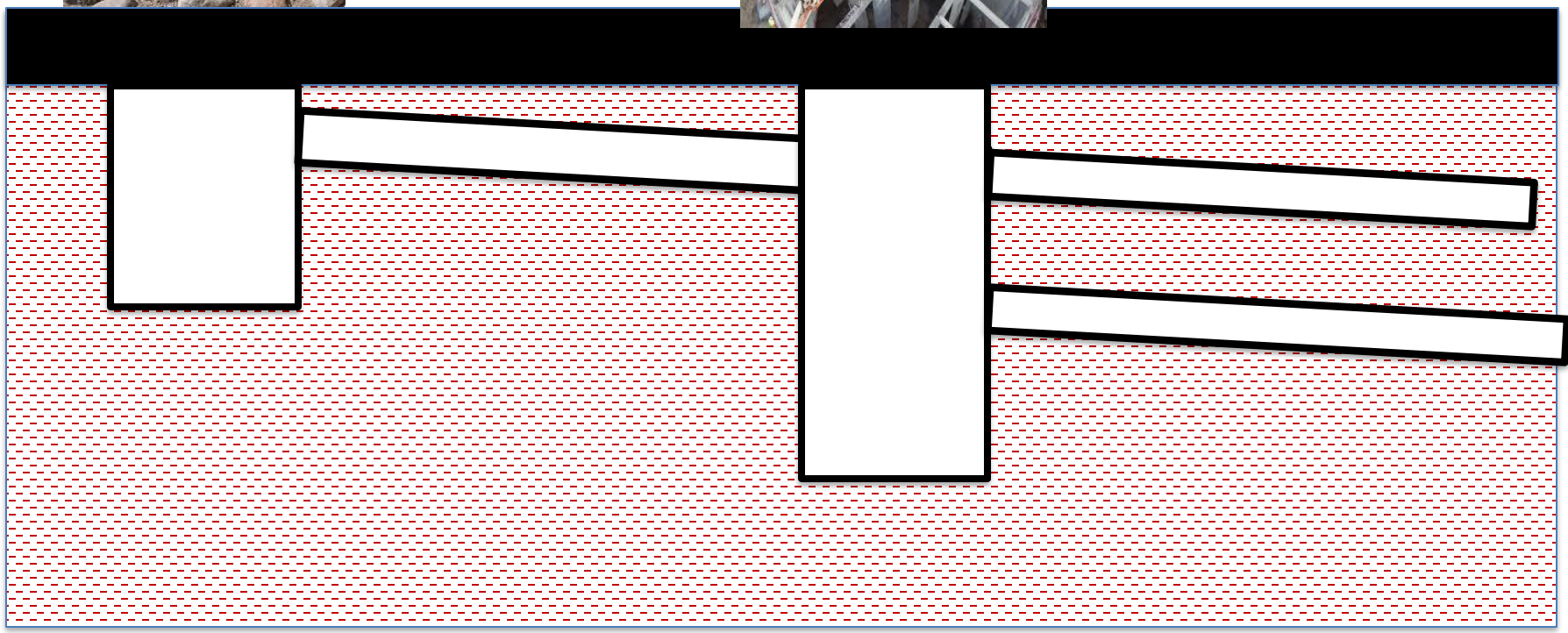
Outline

- Presentation of the sewage system (how does it works ?)
- Smart sewage system concept
- Smart pilot project (SunRise)

Smart sewage system

- Objectifs
- Monitoring ?
- Data analysis (real – time) ?
- Control ?

Water collection



Monitoring system

Weather station

Water quality

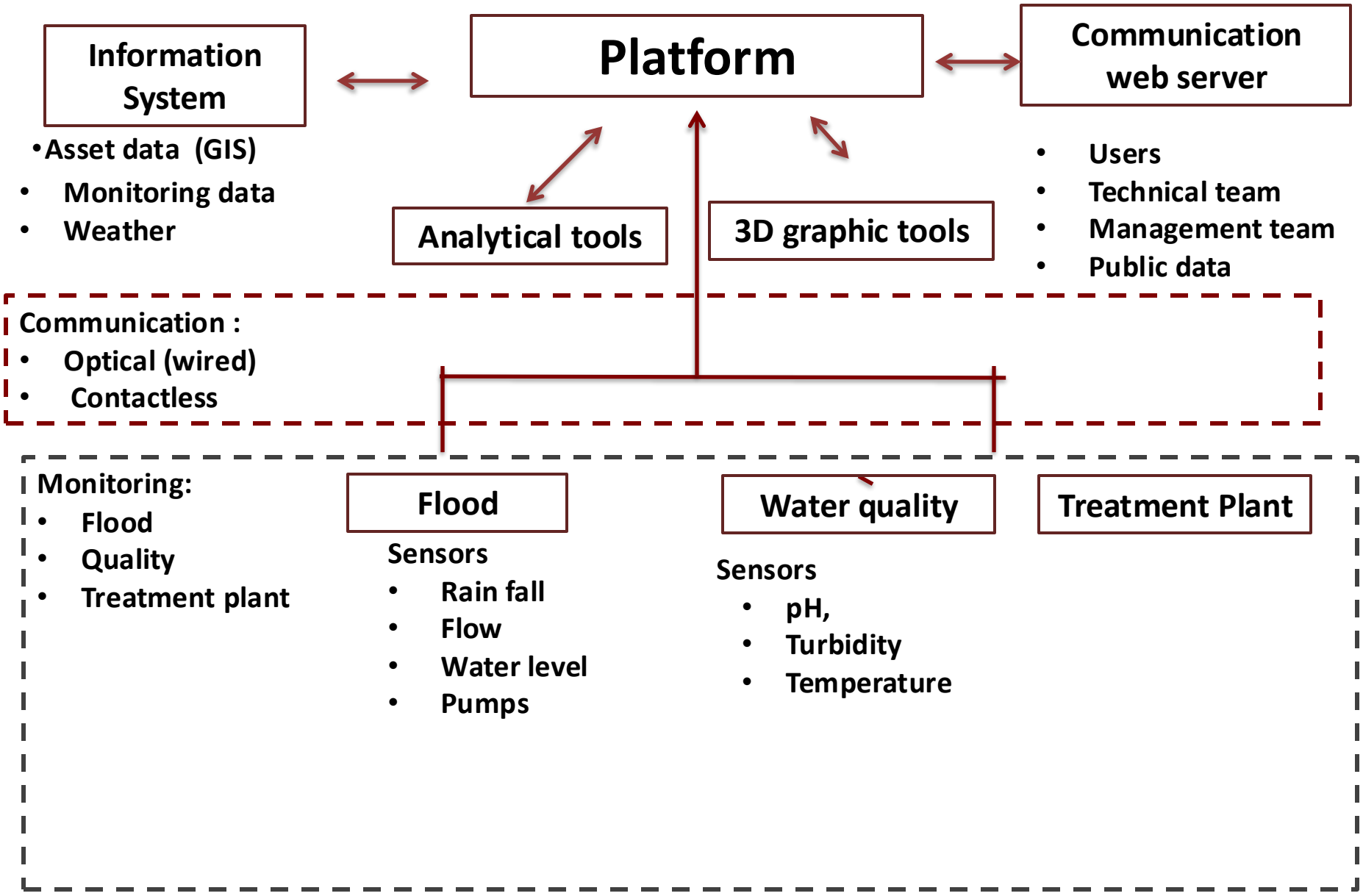
Water level

Water flow

Water level

Water quality

Smart sewage System



Jarsun Technologies - Cloud Based Sewerage Monitoring System

Sewer SMART Drainage Management Software

SCADA - Smart technology to run a sophisticated water and sewerage network

Outline

- Presentation of the sewage system (how does it works ?)
- Smart sewage system concept
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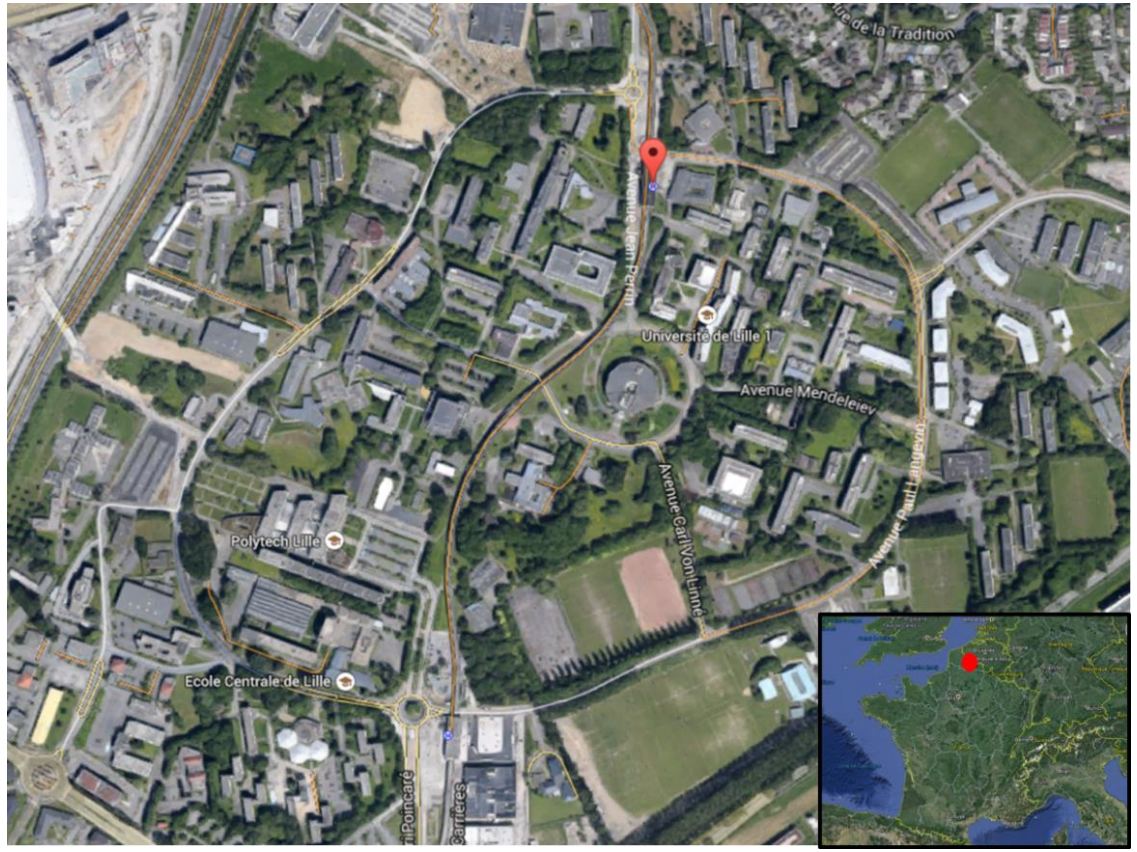
Smart sewage system: SunRise project

Campus of Lille University

- 110 Hectares
- 145 Buildings
- 25 000 users



Separated sewage system:

- Stormwater
- Wastewater

Objectives of the smart system:

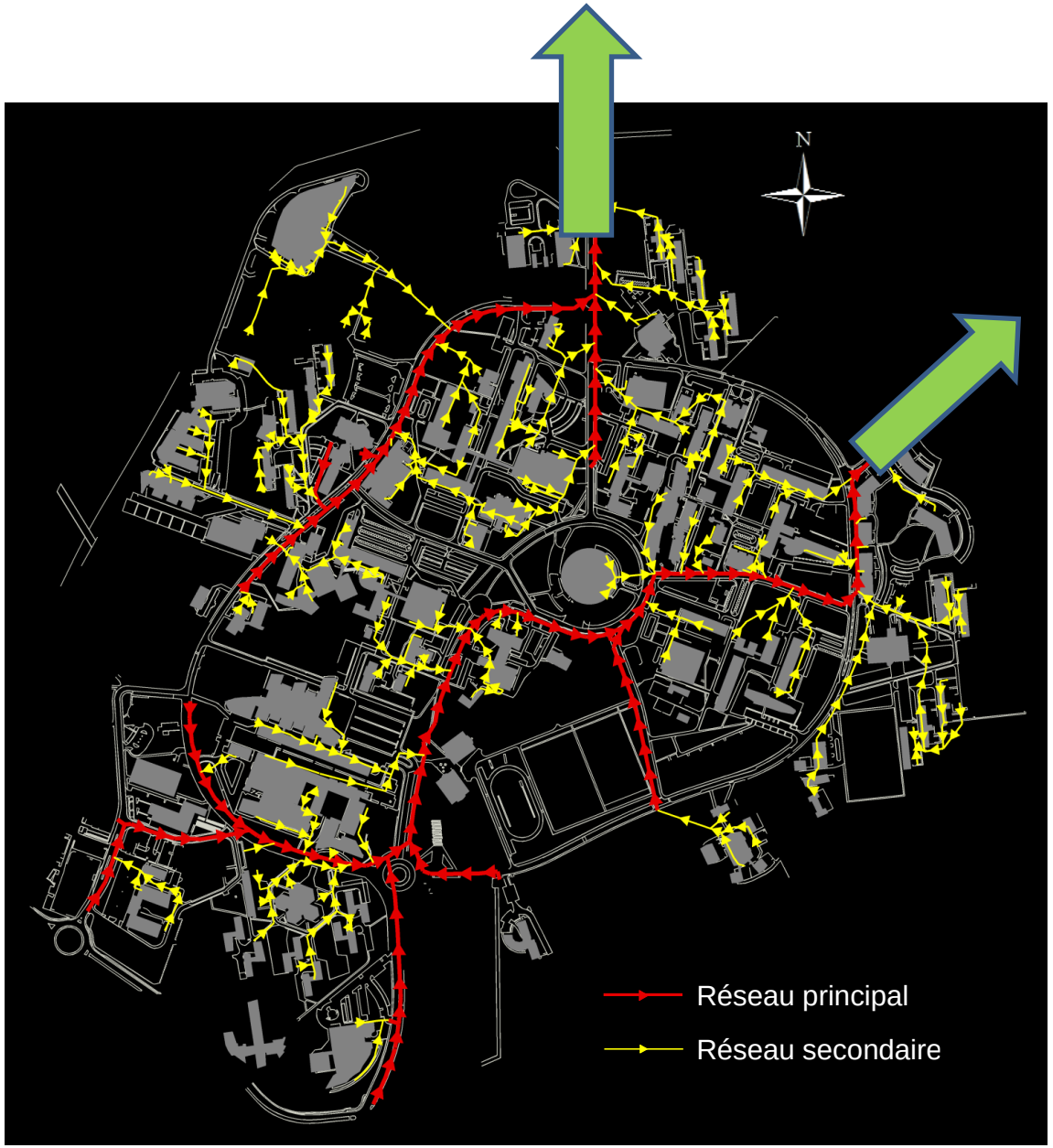
- Enhance understanding of the sewage operating system
- Asset management (maintenance, control,...)
- Reduce flood risk
- Control water discharge
- Reporting
- Billing

I- Wastewater system

Main network (4 kM)

Secondary network (12 kM)

- ✓ 1626 inlets and pipes
- ✓ Diameter : 100 to 250 mm



Wastewater system

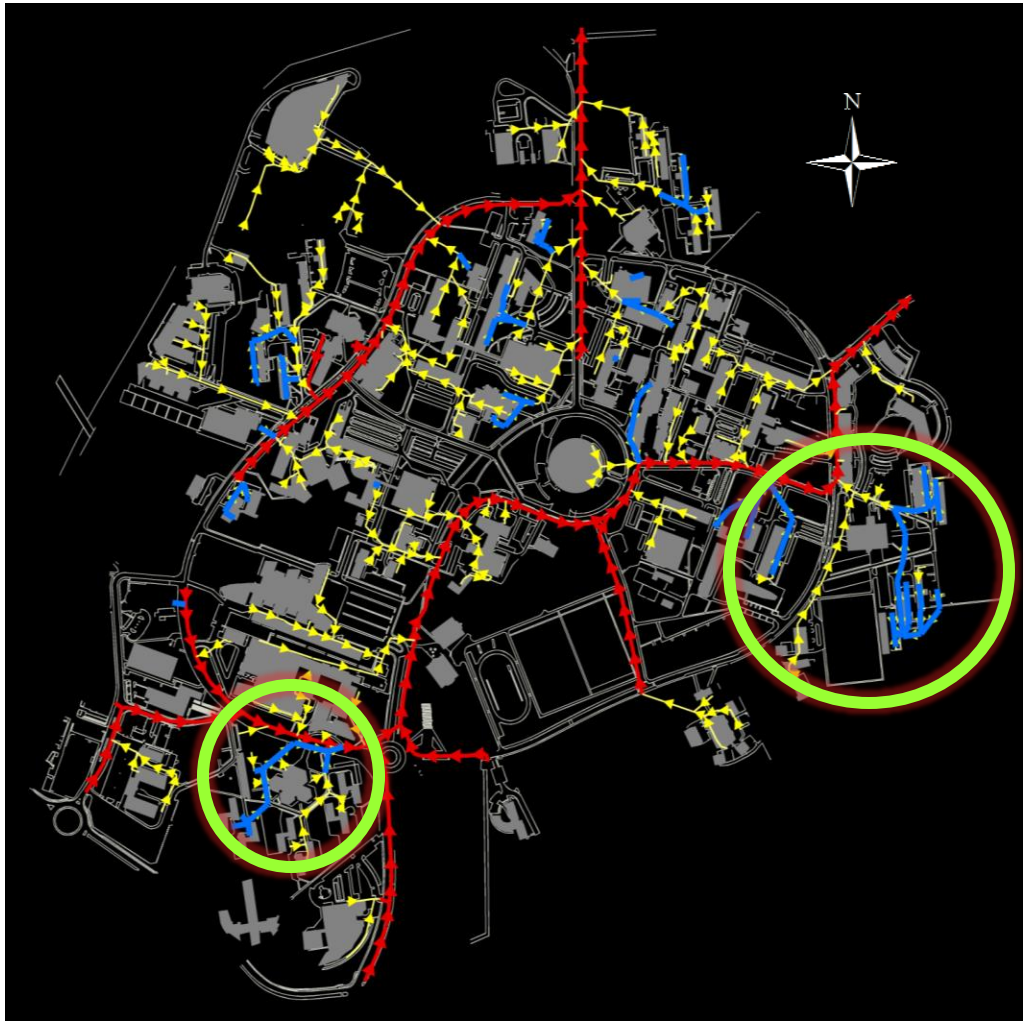
Pompe_relevage

Bac_neutralisation

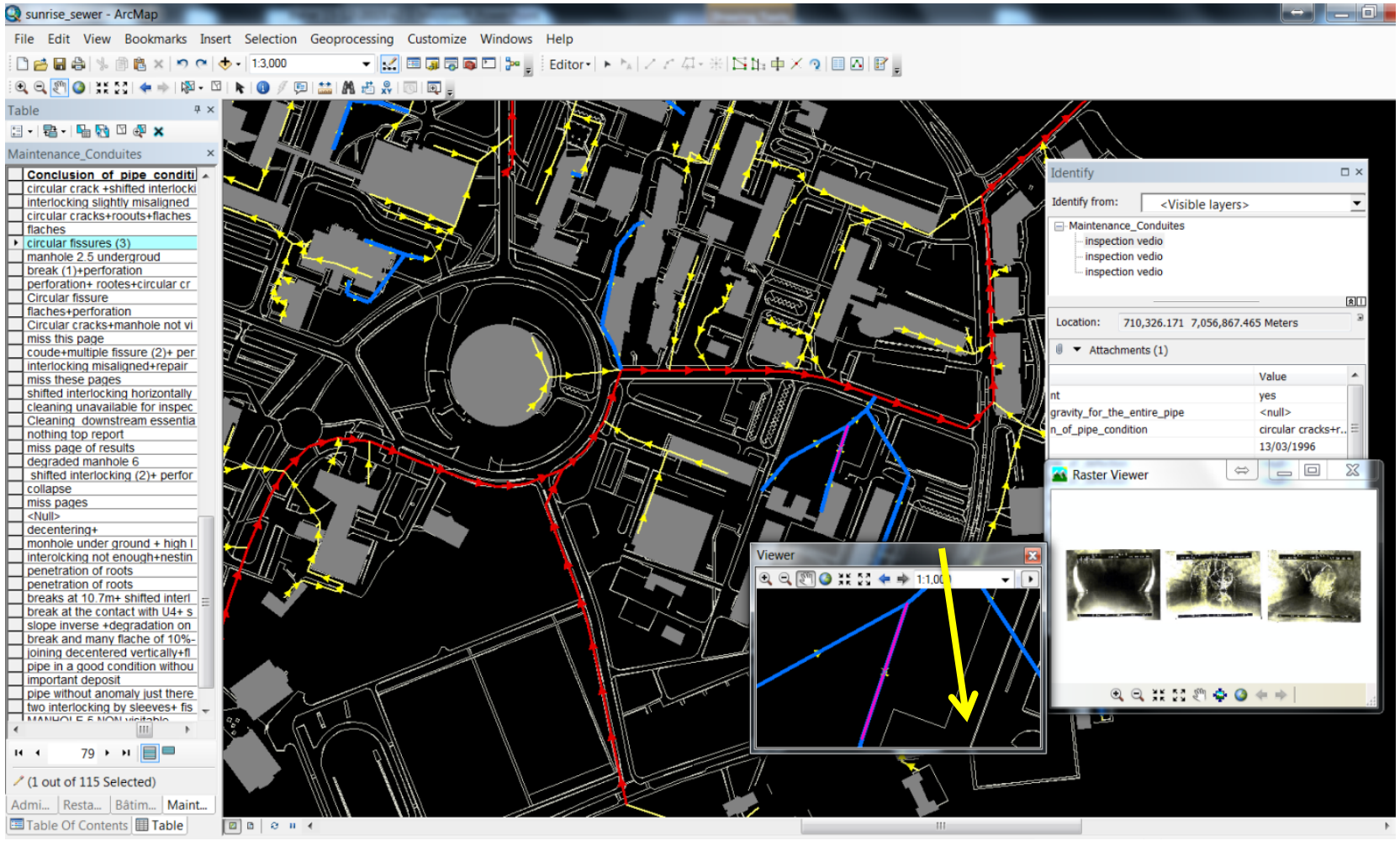
Inspection & Maintenance

- Video Inspection
  - Damage type
  - Severity

- Identification of risk area
- Assessement

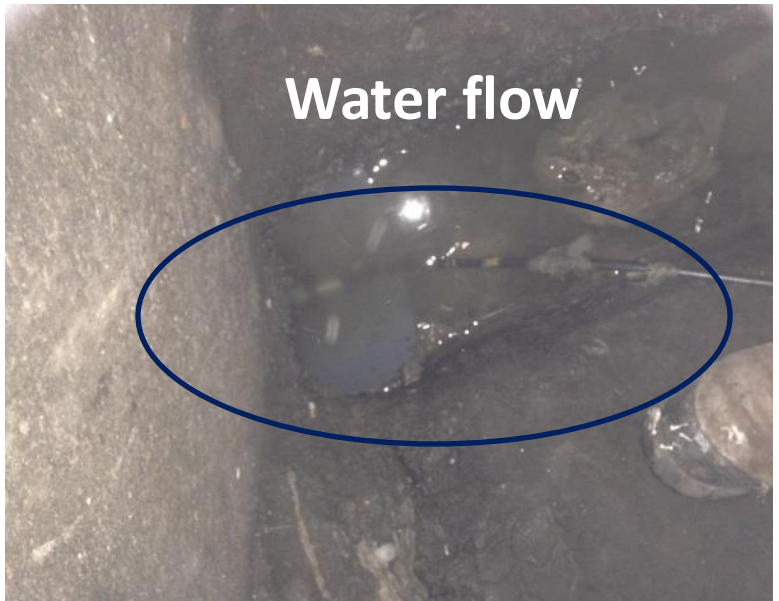


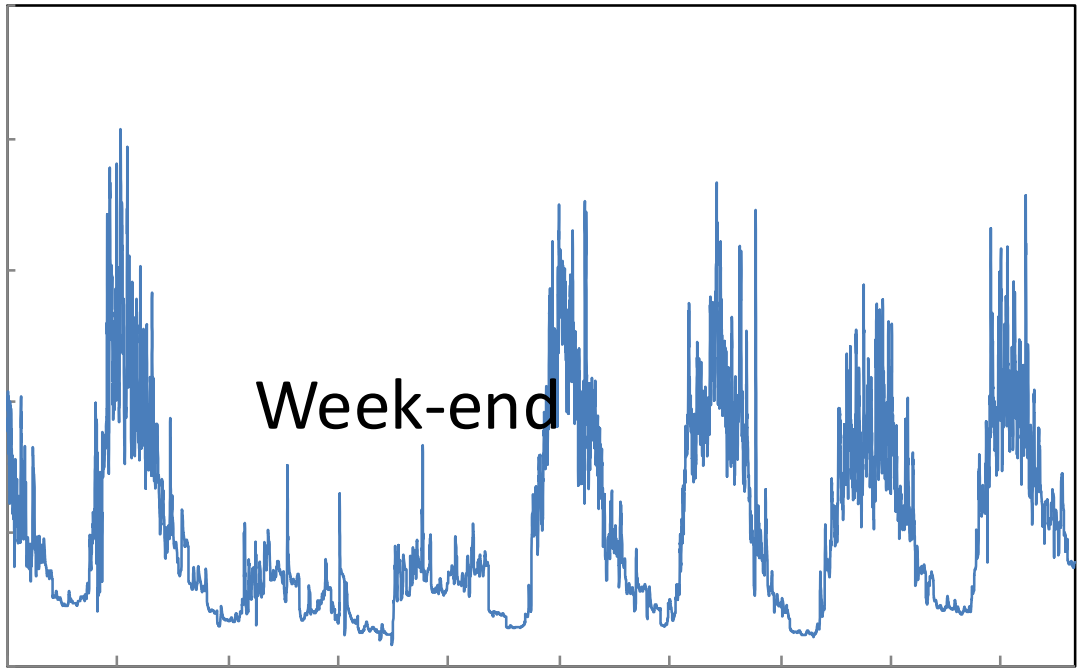
Inspection Video



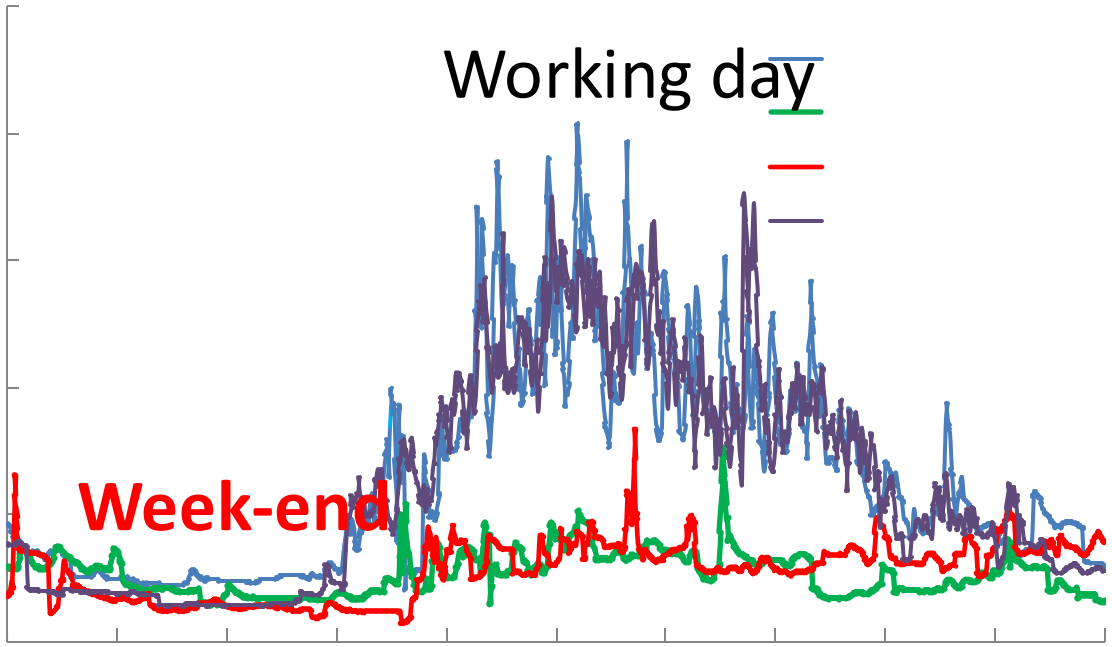
Monitoring area

Hydraulic parameters





Water flow



Average flow

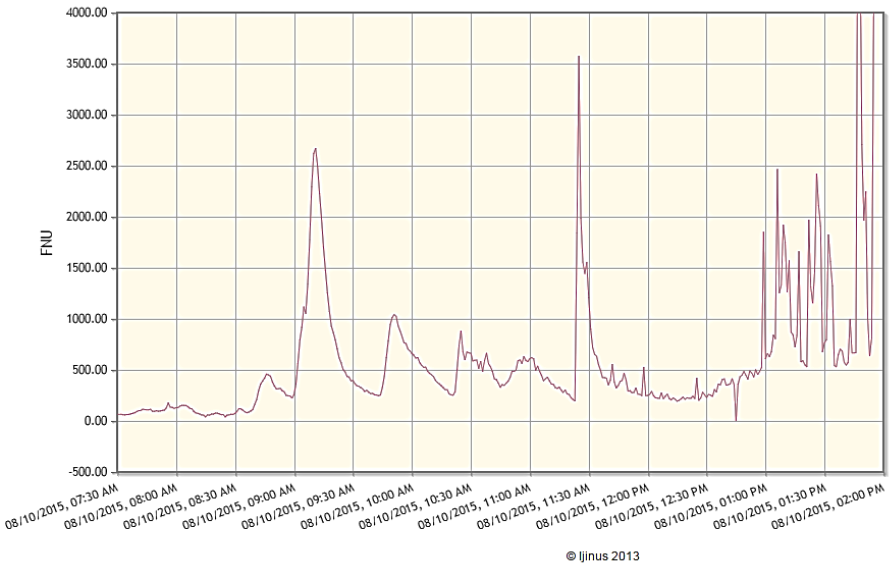
- 2.7 m^3/h (Weekend)
- 6.3 m^3/h (working day)

Maximum flow

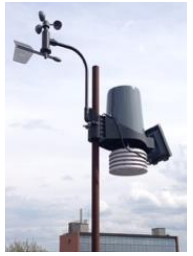
- 7.5 m^3/h (Weekend)
- 20 m^3/h (working day)

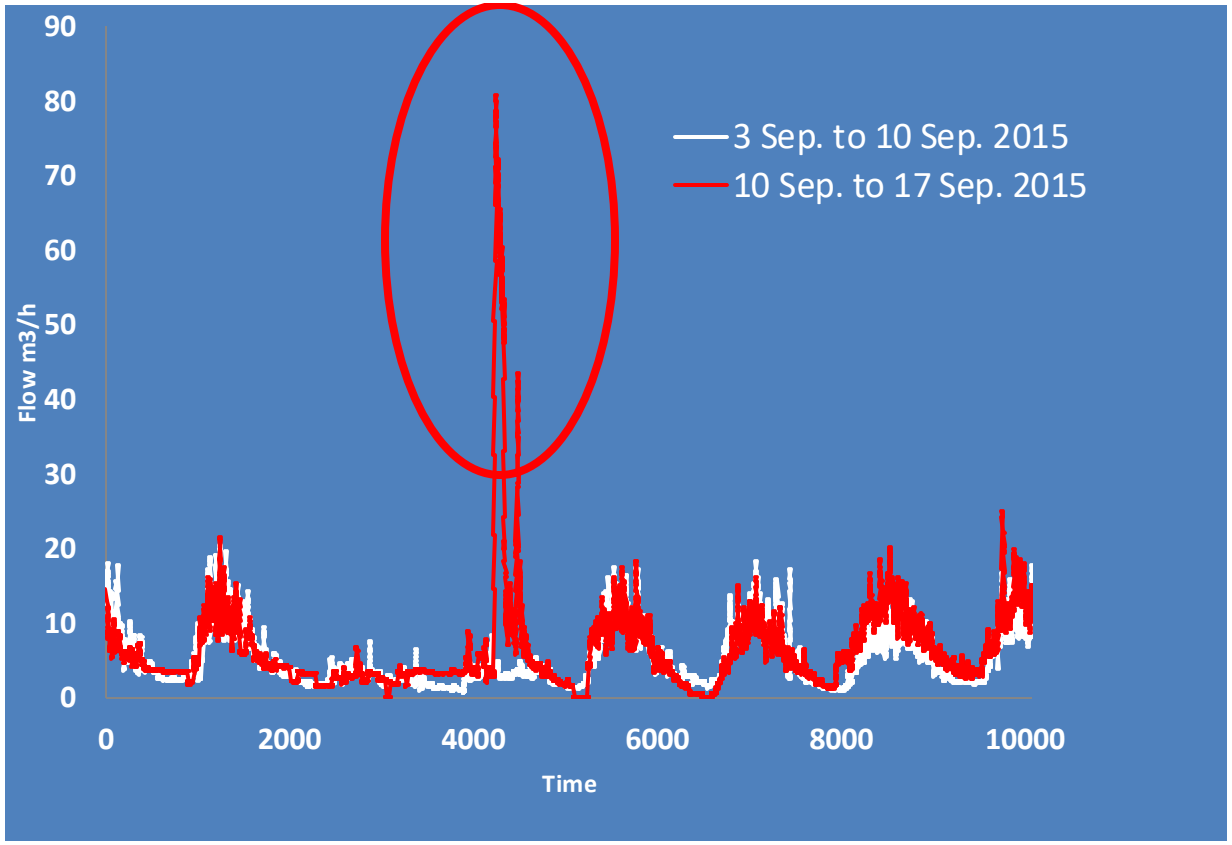
Water quality

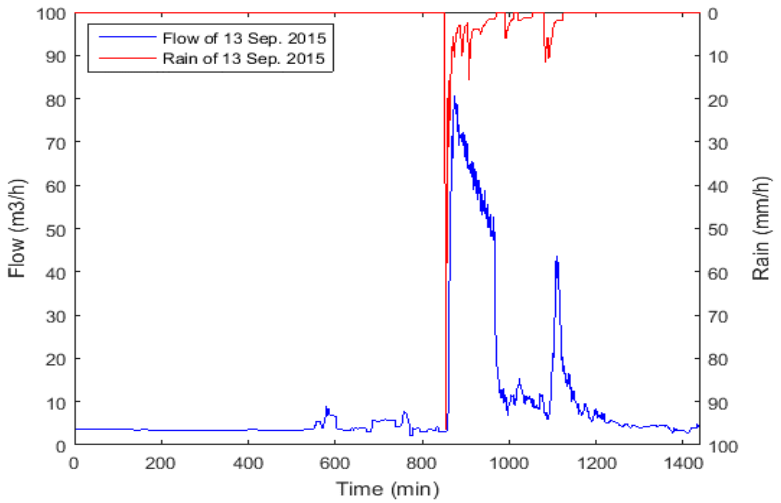
Turbidity



Abnormal event in the wastewater system



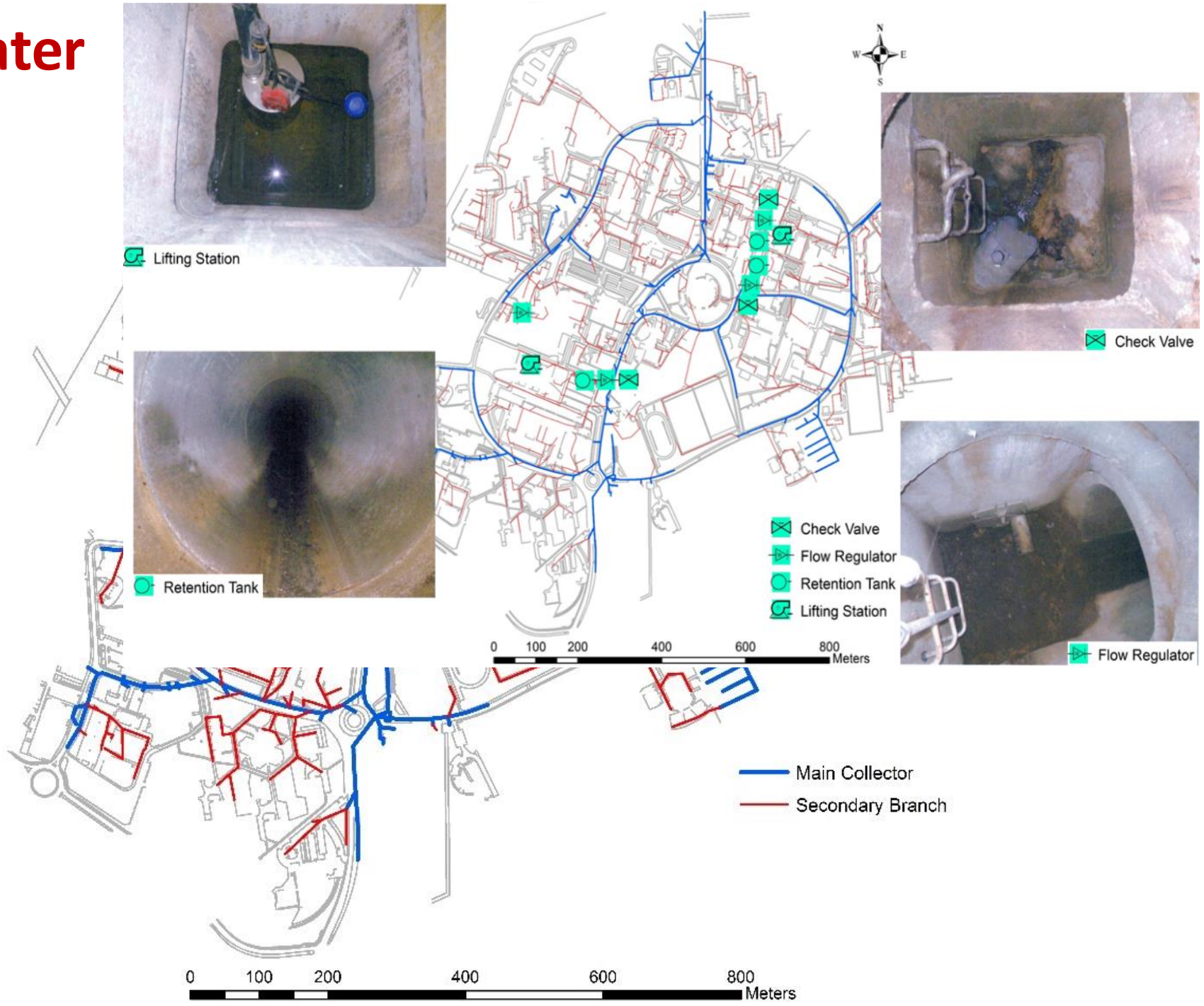




Rainfall

Storm Water

Storm Water


Lifting Station
Retention Tank
Check Valve
Flow Regulator
Retention Tank
Lifting Station
0 100 200 400 600 800
Meters
Check Valve
Flow Regulator
Main Collector
Secondary Branch
0 100 200 400 600 800
Meters

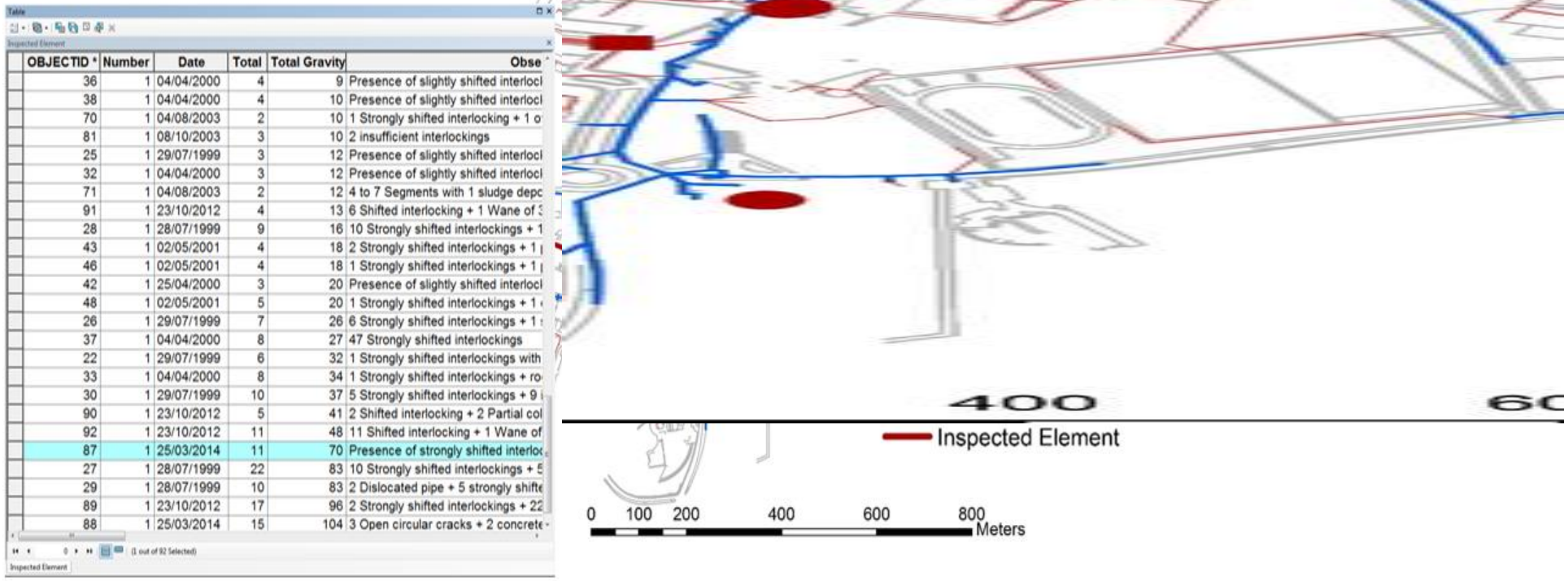
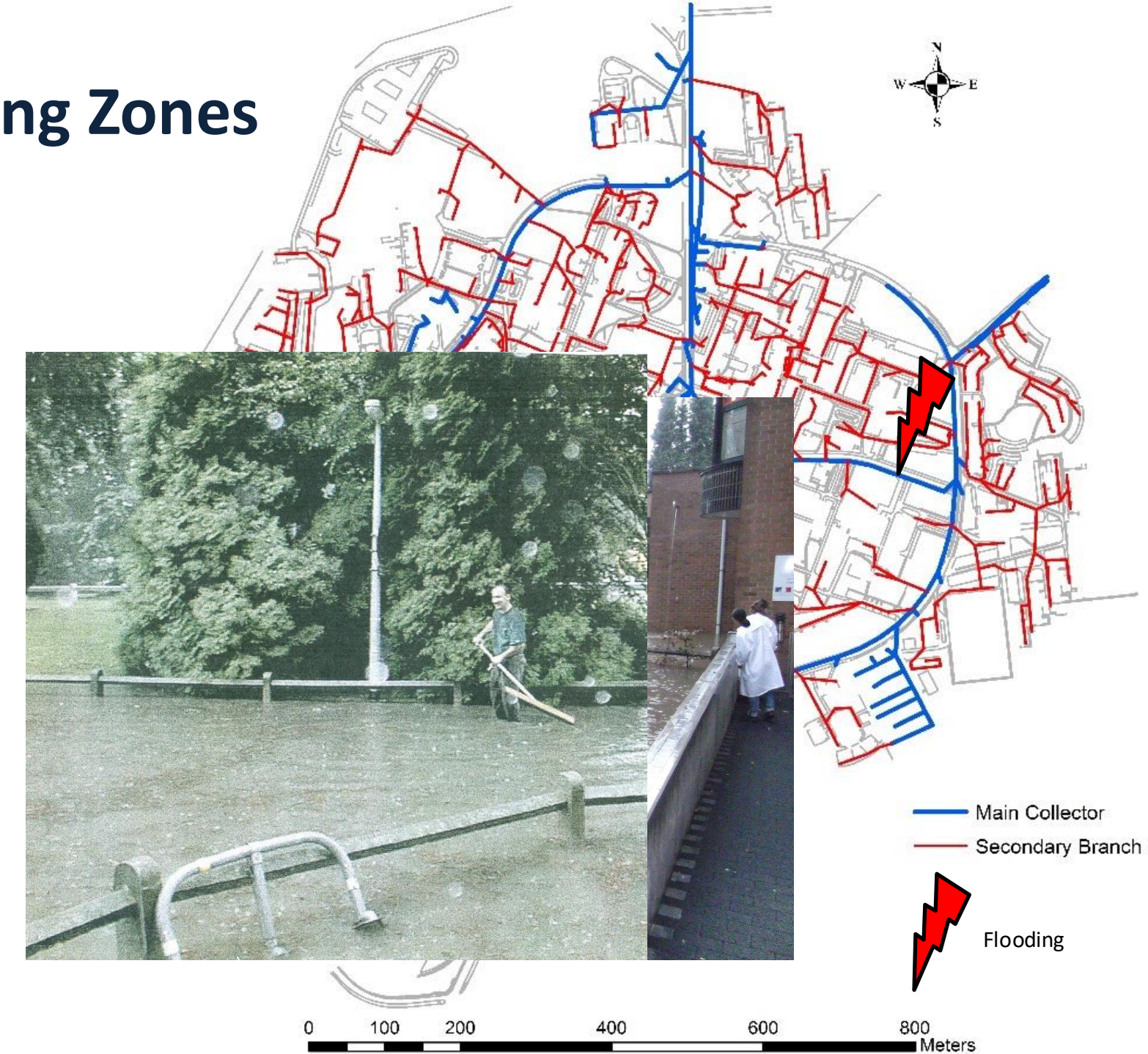
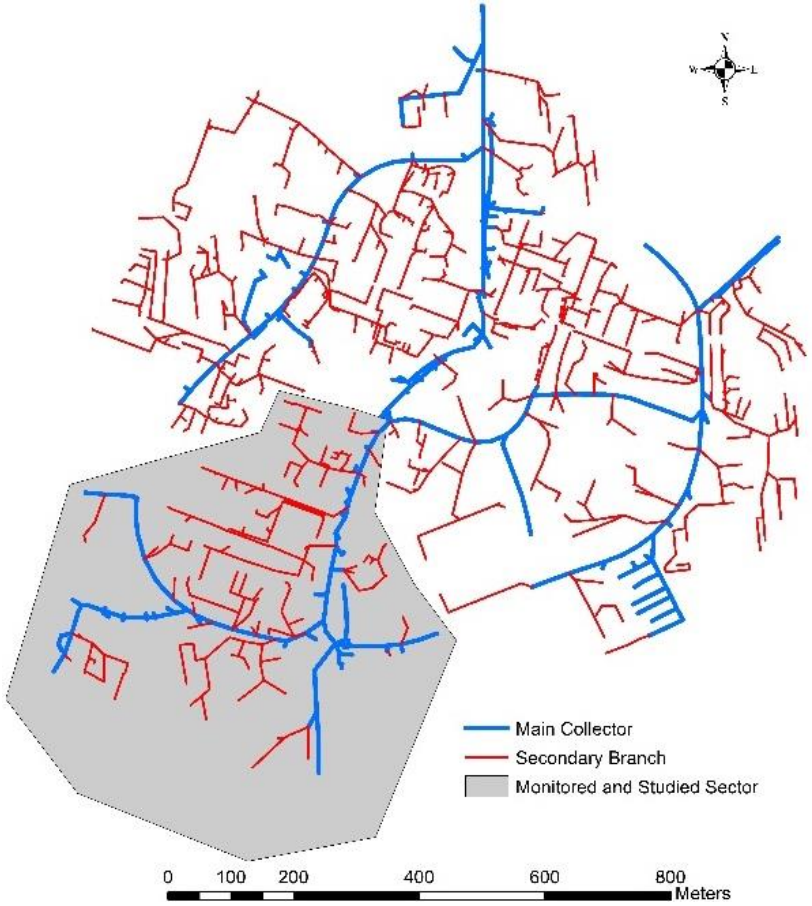


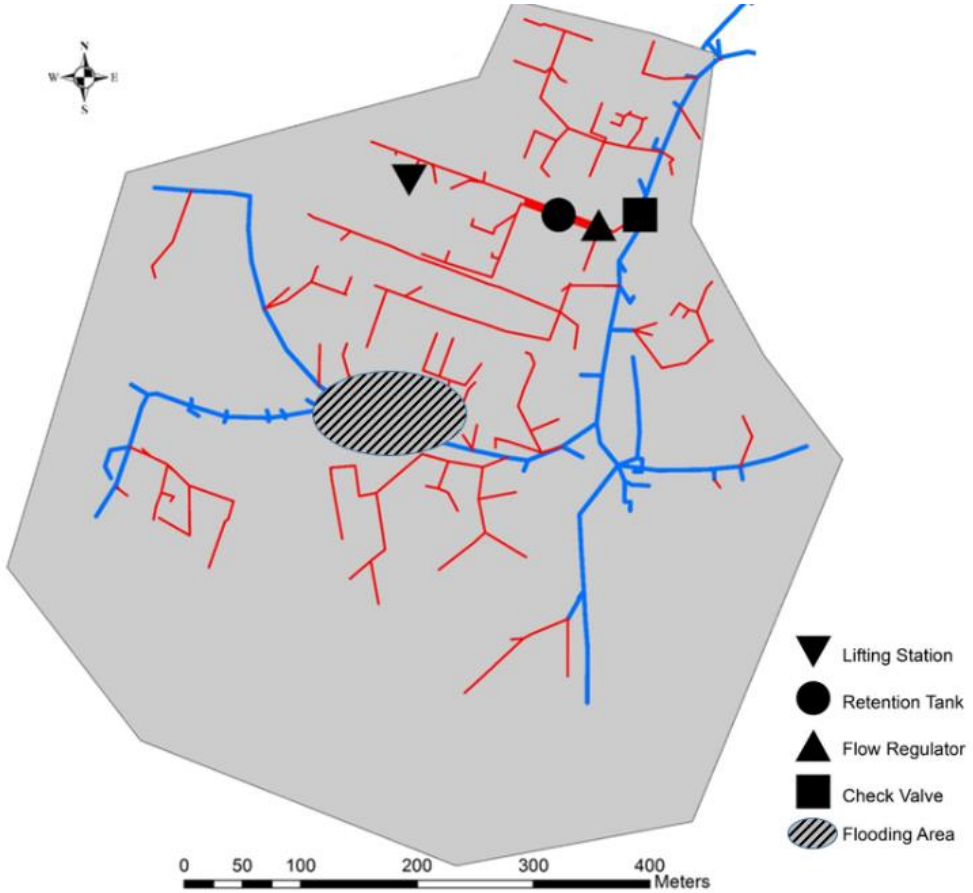
Table
Inspected Element
OBJECTID * | Number | Date | Total | Total Gravity | Obse
36 | 1 | 04/04/2000 | 4 | 9 | Presence of slightly shifted interlocl
38 | 1 | 04/04/2000 | 4 | 10 | Presence of slightly shifted interlocl
70 | 1 | 04/08/2003 | 2 | 10 | 1 Strongly shifted interlocking + 1 o
81 | 1 | 08/10/2003 | 3 | 10 | 2 insufficient interlockings
25 | 1 | 29/07/1999 | 3 | 12 | Presence of slightly shifted interlocl
32 | 1 | 04/04/2000 | 3 | 12 | Presence of slightly shifted interlocl
71 | 1 | 04/08/2003 | 2 | 12 | 4 to 7 Segments with 1 sludge depc
91 | 1 | 23/10/2012 | 4 | 13 | 6 Shifted interlocking + 1 Wane of 3
28 | 1 | 28/07/1999 | 9 | 16 | 10 Strongly shifted interlockings + 1
43 | 1 | 02/05/2001 | 4 | 18 | 2 Strongly shifted interlockings + 1
46 | 1 | 02/05/2001 | 4 | 18 | 1 Strongly shifted interlockings + 1
42 | 1 | 25/04/2000 | 3 | 20 | Presence of slightly shifted interlocl
48 | 1 | 02/05/2001 | 5 | 20 | 1 Strongly shifted interlockings + 1
26 | 1 | 29/07/1999 | 7 | 26 | 6 Strongly shifted interlockings + 1
37 | 1 | 04/04/2000 | 8 | 27 | 47 Strongly shifted interlockings
22 | 1 | 29/07/1999 | 6 | 32 | 1 Strongly shifted interlockings with
33 | 1 | 04/04/2000 | 8 | 34 | 1 Strongly shifted interlockings + ro
30 | 1 | 29/07/1999 | 10 | 37 | 5 Strongly shifted interlockings + 9
90 | 1 | 23/10/2012 | 5 | 41 | 2 Shifted interlocking + 2 Partial col
92 | 1 | 23/10/2012 | 11 | 48 | 11 Shifted interlocking + 1 Wane of
87 | 1 | 25/03/2014 | 11 | 70 | Presence of strongly shifted interloc
27 | 1 | 28/07/1999 | 22 | 83 | 10 Strongly shifted interlockings + 5
29 | 1 | 28/07/1999 | 10 | 83 | 2 Dislocated pipe + 5 strongly shifte
89 | 1 | 23/10/2012 | 17 | 96 | 2 Strongly shifted interlockings + 22
88 | 1 | 25/03/2014 | 15 | 104 | 3 Open circular cracks + 2 concrete
(1 out of 92 Selected)
Inspected Element
2
400
Inspected Element
0 100 200 400 600 800
Meters

Flooding Zones



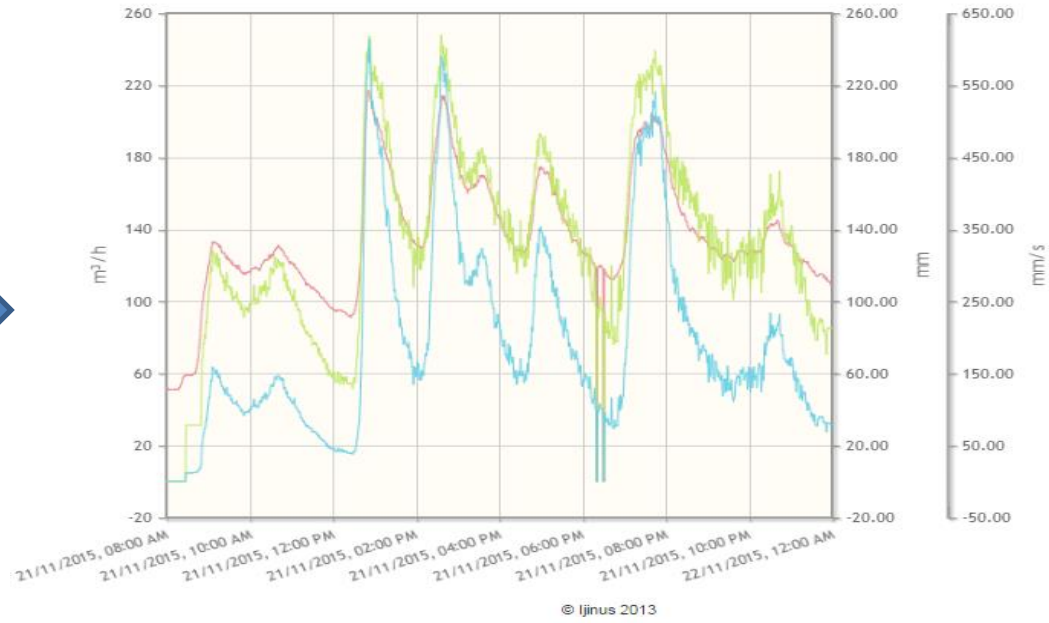
Studied Sector



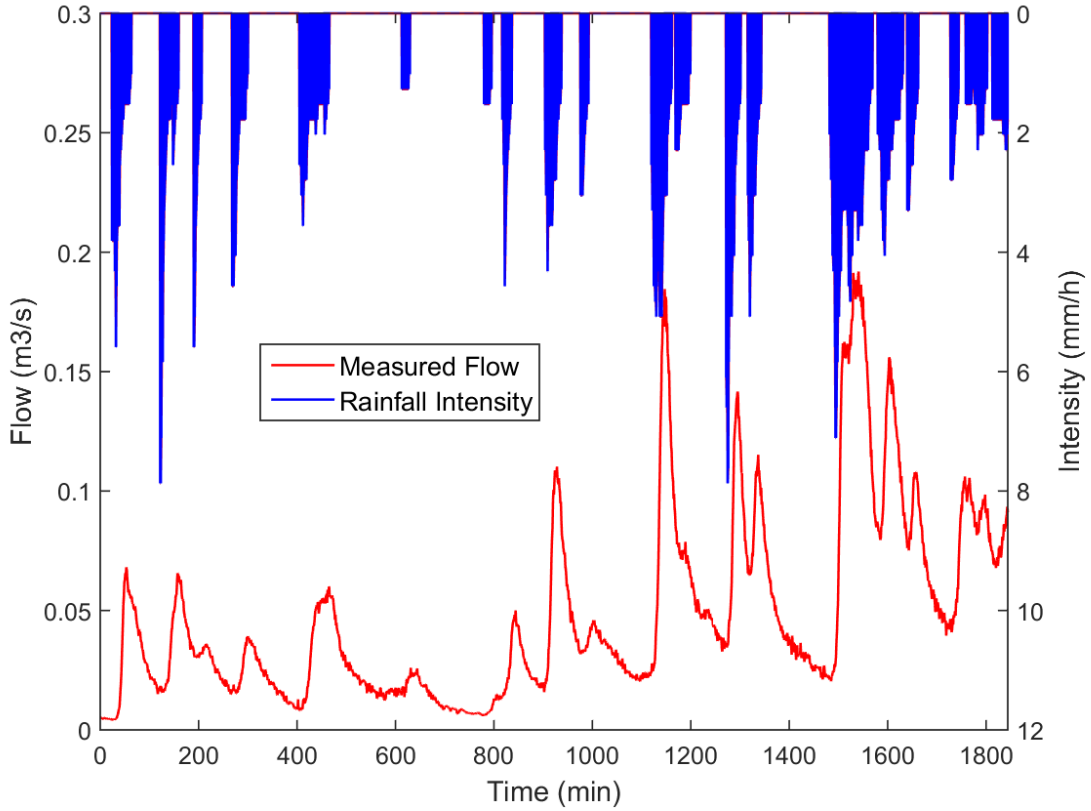



200


ijinus

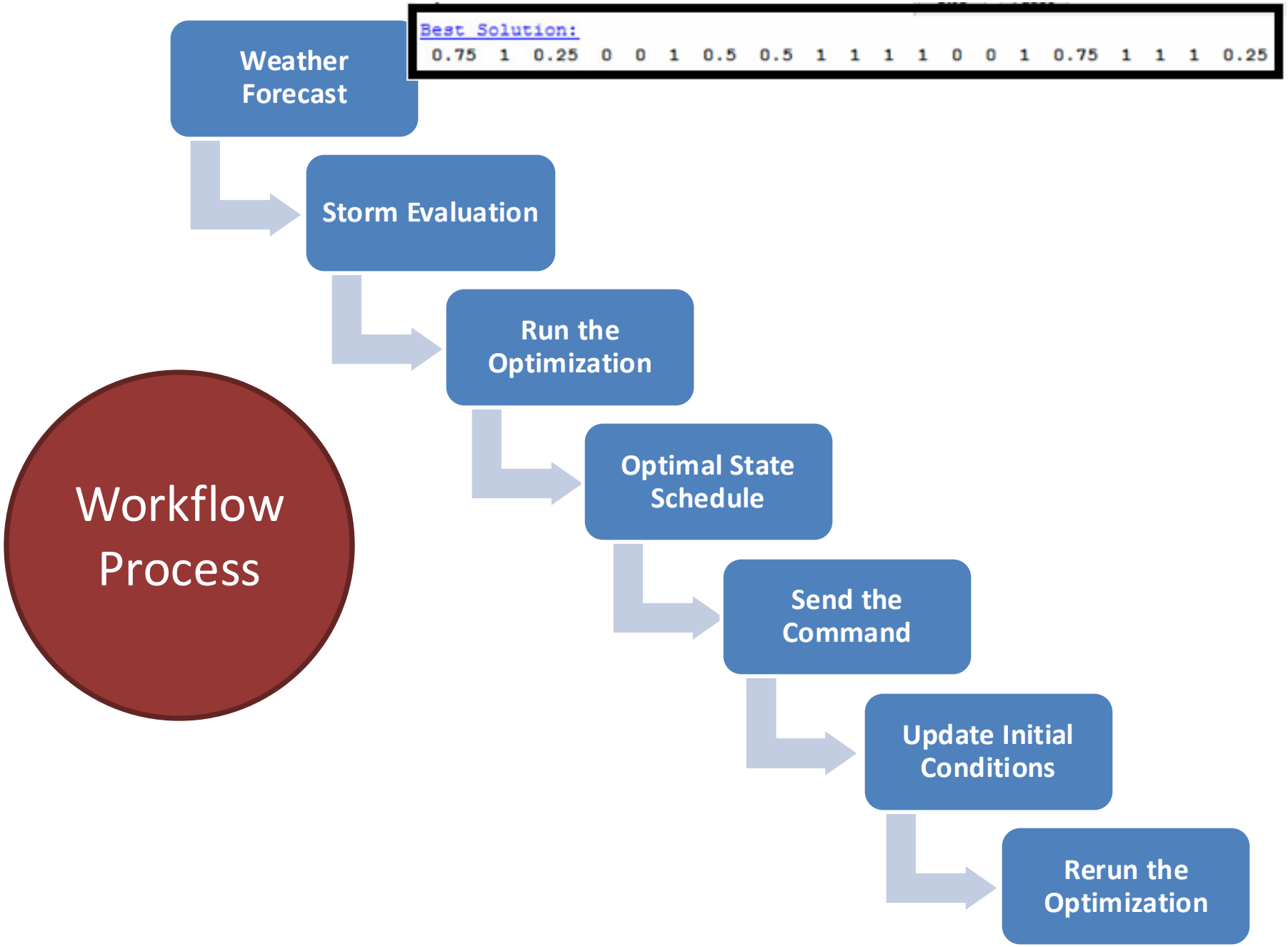

m³/h
mm
mm/s
260
220
180
140
100
60
20
-20
260.00
220.00
180.00
140.00
100.00
60.00
20.00
-20.00
650.00
550.00
450.00
350.00
250.00
150.00
50.00
-50.00
21/11/2015, 08:00 AM
21/11/2015, 10:00 AM
21/11/2015, 12:00 PM
21/11/2015, 02:00 PM
21/11/2015, 04:00 PM
21/11/2015, 06:00 PM
21/11/2015, 08:00 PM
21/11/2015, 10:00 PM
22/11/2015, 12:00 AM
© Ijinus 2013

Example of recorded data

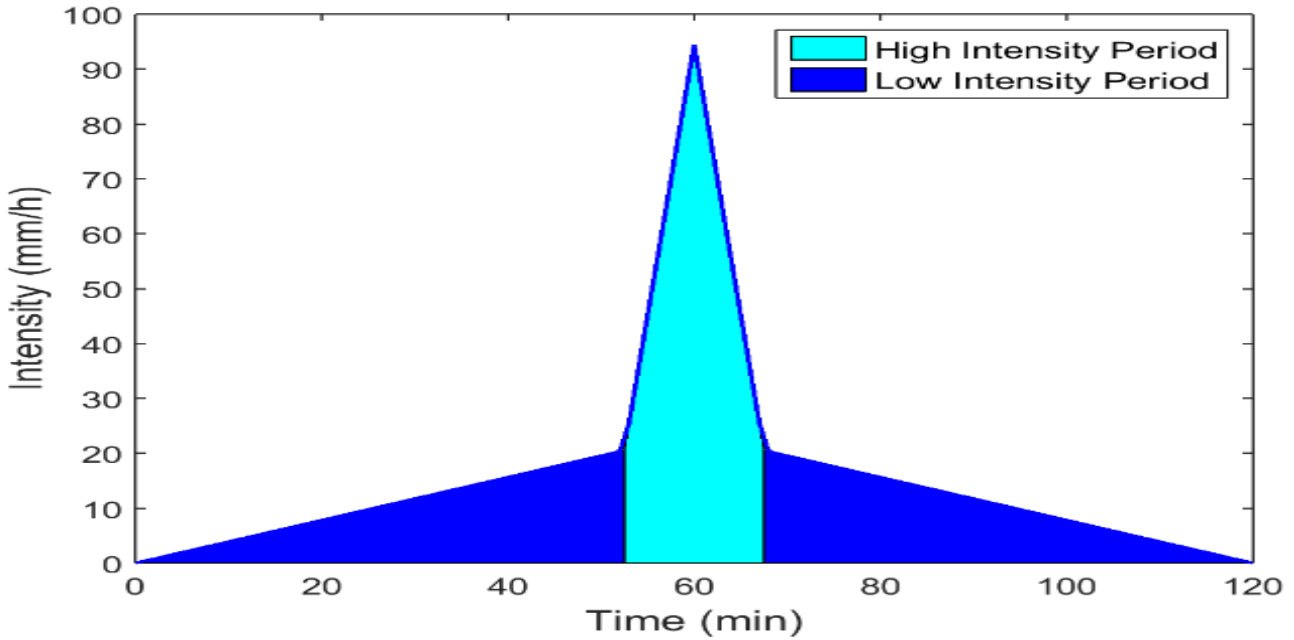


Correlations between the Measurements

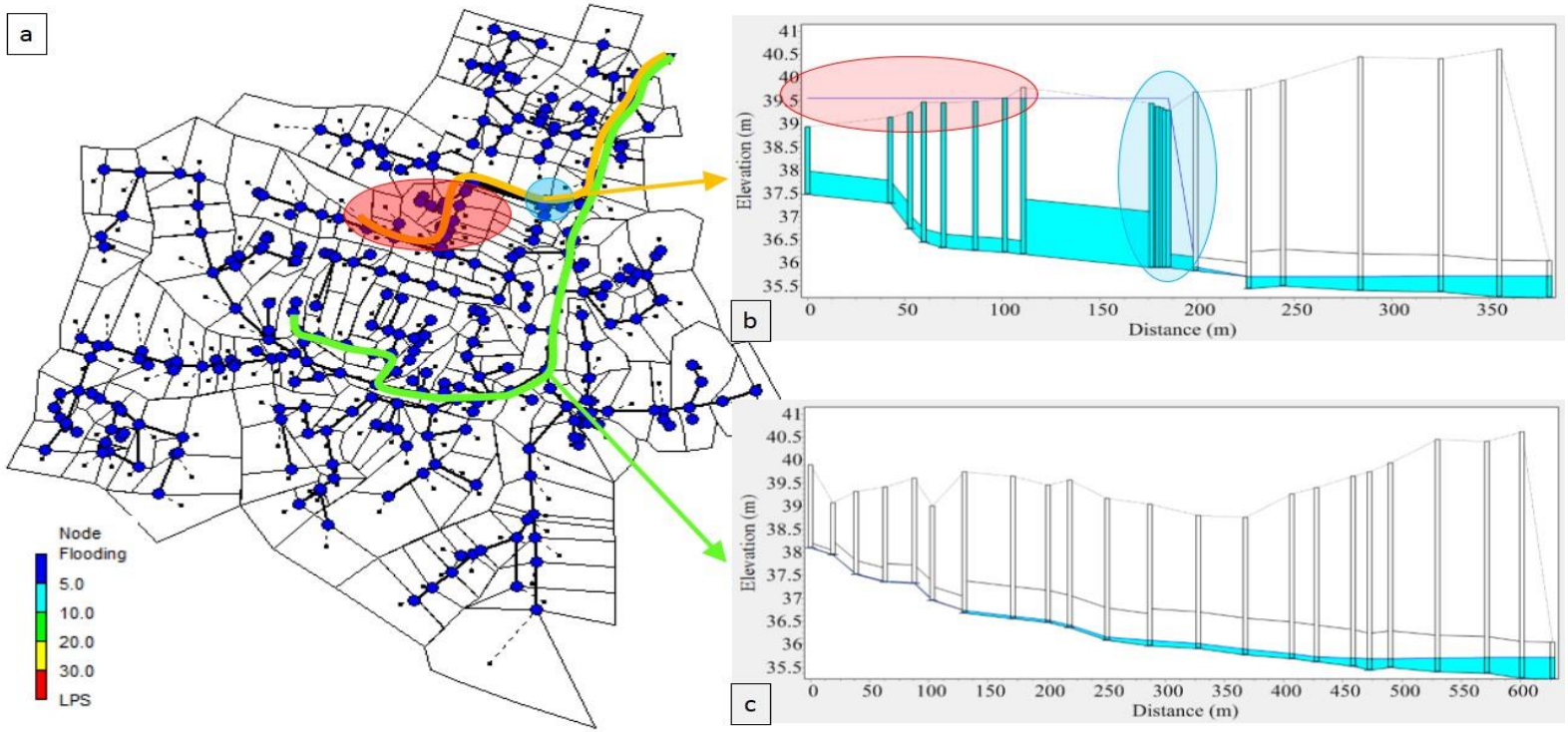
Flood analysis


Best Solution:
0.75 1 0.25 0 0 1 0.5 0.5 1 1 1 1 0 0 1 0.75 1 1 1 0.25
Weather Forecast
Storm Evaluation
Run the Optimization
Optimal State Schedule
Send the Command
Update Initial Conditions
Rerun the Optimization
Workflow Process

Rainfall: 5 Year Return Period



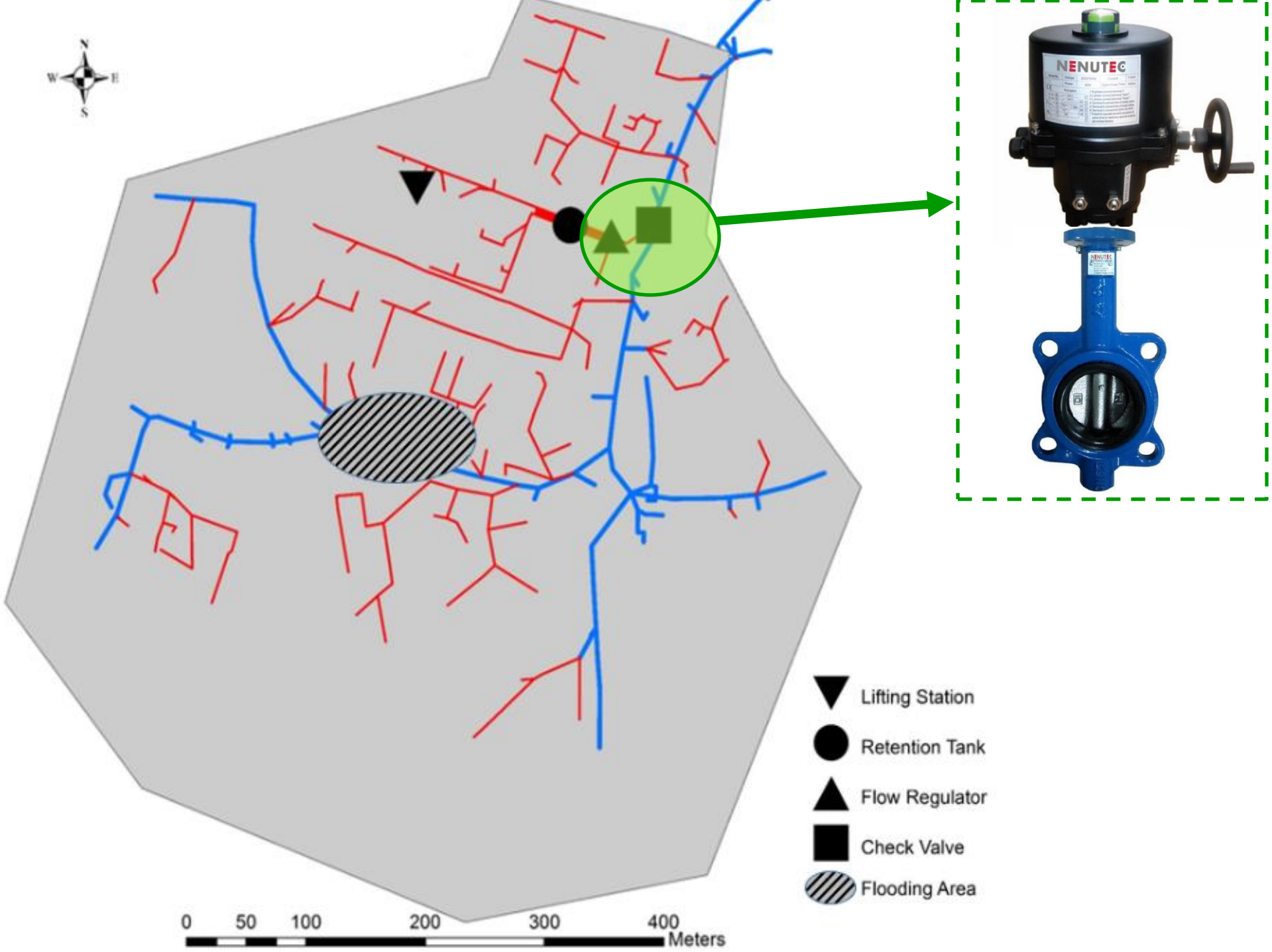
5 YRP after 3:03



Flow Regulator

Flooding 1013 m^3

By Removing Static Equipment 889 m^3


N
W
E
S
NENUTEC
Lifting Station
Retention Tank
Flow Regulator
Check Valve
Flooding Area
0
50
100
200
300
400
Meters

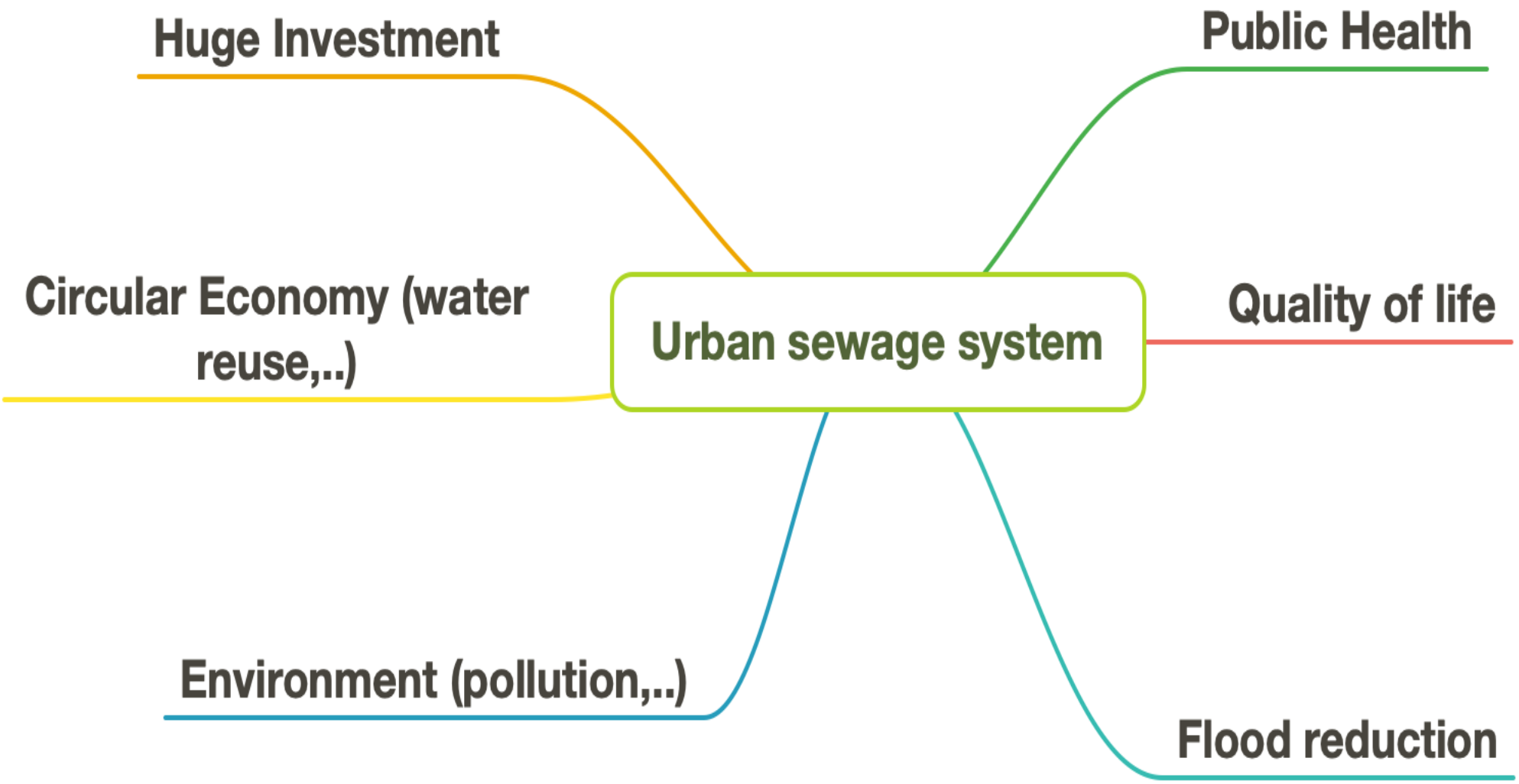
Rainfall: 5 Year Return Period

Flood volume:

- Initial= 1013 m^3
- After removing static equipment: 889 m^3 (12 % Reduction)
- With flow regulator: 828 m^3 (18 % Reduction)

Conclusion

sewage systems: Major urban concern



Challenges of sewage systems

Stormwater

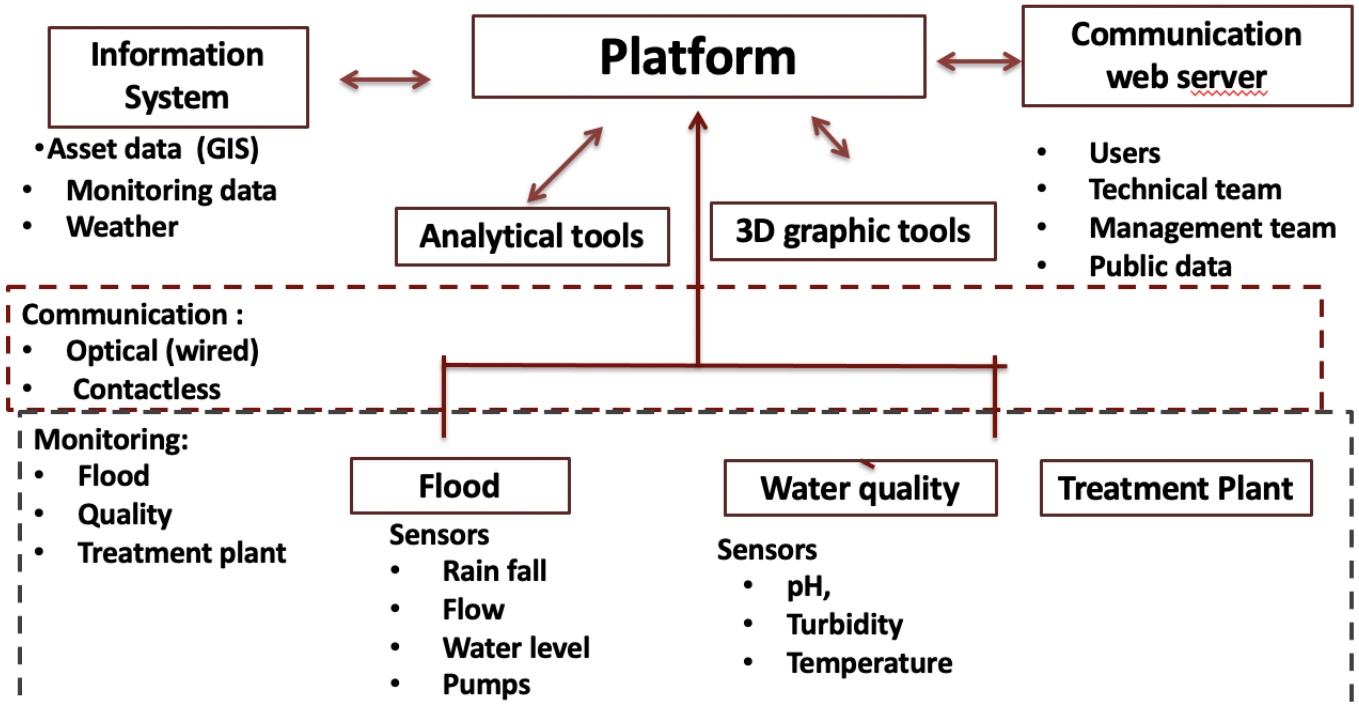
- Reduce flood risk
- Reduce risk of contamination
- Preservation of rainwater by infiltration and transport for natural water resources
- Re-use of rainwater (domestic, industrial..)

Wastewater

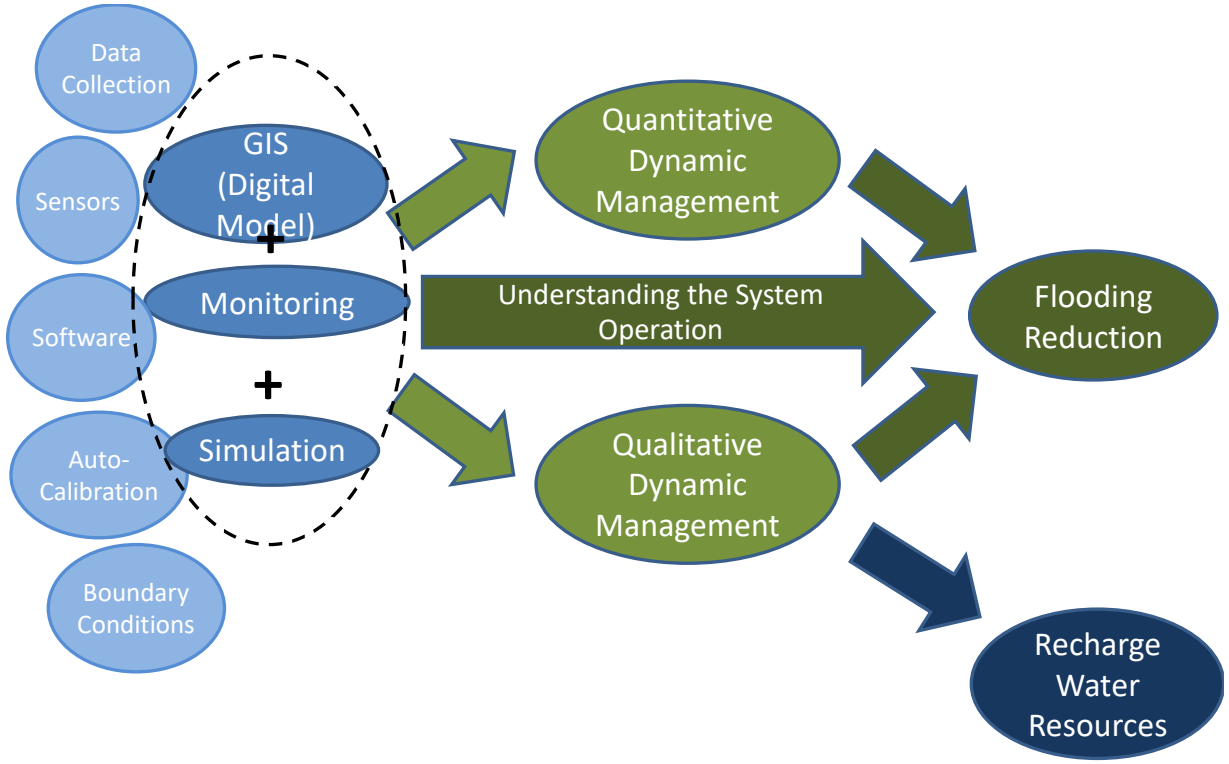
- Reduce contamination risk (Health, environment)
- Re-use of wastewater (domestic, industrial..)

- Optimal management (collection, transport, treatment,..)
- Reduction of energy consumption
- Evaluation of the performances
- Optimization of the investement

Smart sewage System



Smart sewage system



Comprehensive and Real-time monitoring

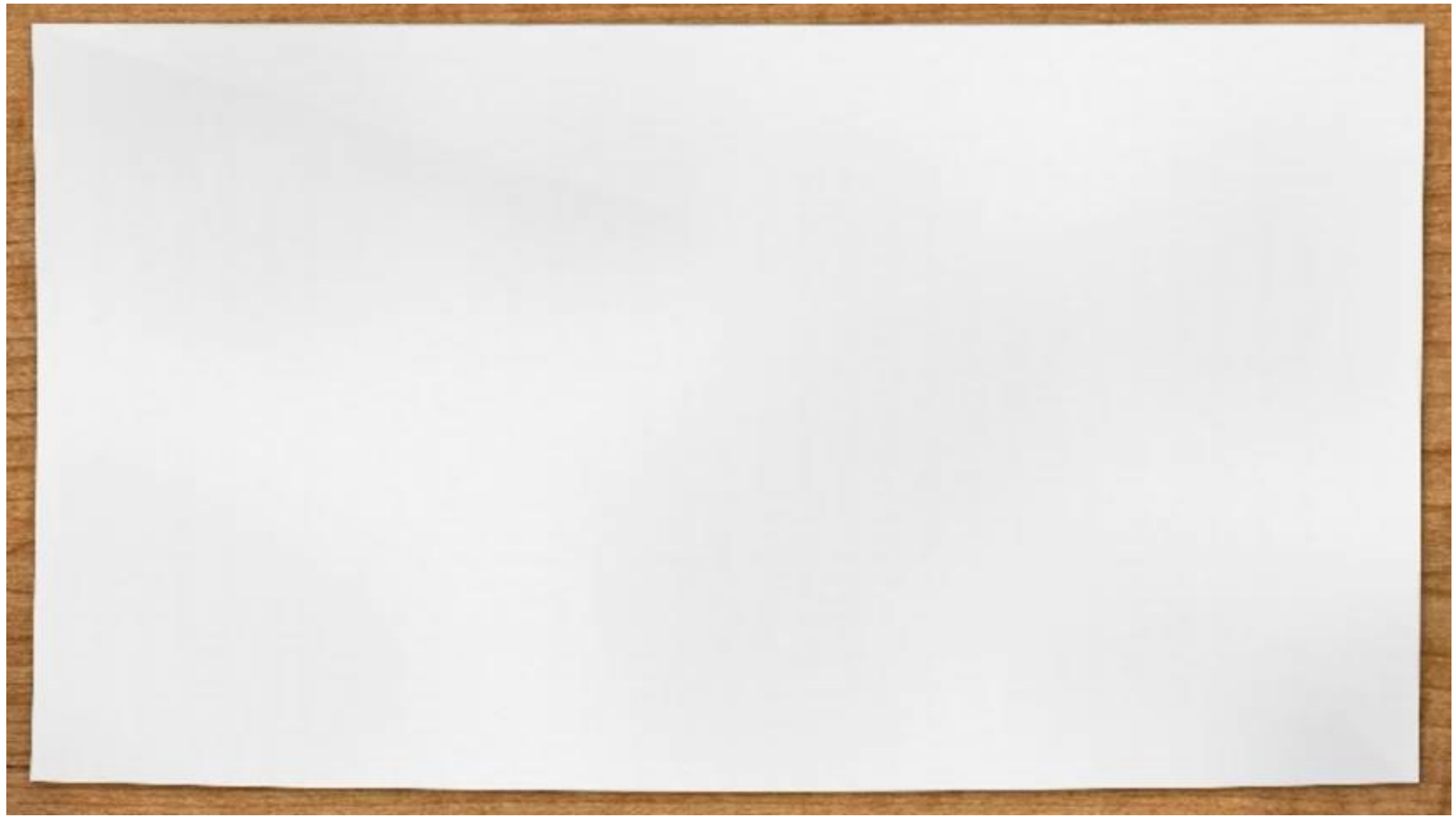
Analysis of real-time and historical data

- Optimal management
- Safety (flood, contamination,..)
- Water reuse
- Performance evaluation

Thank you

Paris sewers - Paris - BBC

Stormwater Management



Wastewater treatment plant - New York

Inspection & Maintenance of the Downstream Defender Stormwater Treatment System